**PAST Logbook (Example)**

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| **Week 1: 13 – 20 September 2024** |
| **13/09/24**  **Worked on Engineers Australia Presentation**   * Rehearsal with team on discord * Wrote script, practiced speaking, took on feedback, gave feedback, made presentation slides * Key lessons: Be time efficient with words, tone is important to keep audience engaged, balance pictures and words on slides. |
| **15/09/24**  **Pre-study & planning for magnetorquer driver circuit**   * Learnt what components are required and how the basic schematic works * Will probably not implement detumbling algorithm yet since the driver will only be for one rod at first.     **Magnetorquer Driver Resources**  <https://courses.grainger.illinois.edu/ece445/getfile.asp?id=16327>   * Good, brief, but covers basics components of PCB   <https://acris.aalto.fi/ws/portalfiles/portal/88686047/Design_of_Magnetorquer_Based_Attitude_Control_Subsystem_for_FORESAIL_1_Satellite.pdf>   * Lots of theory and simulations. In depth explanation on how the circuit work.   <https://www.researchgate.net/publication/363739811_Laboratory-Scale_Demonstration_of_a_Distributed_Magnetorquer_Array_for_the_Attitude_Control_of_Large_Space_Structures>  [file:///C:/Users/Zebon/Downloads/DistMagIAC\_Final-compressed.pdf](file:///C:\Users\Zebon\Downloads\DistMagIAC_Final-compressed.pdf)   * Paper is about magnetorquers for large scale spacecrafts. Still contains some valuable info on circuitry. Well documented design process.   <https://ieeexplore.ieee.org/document/9468712>   * Really good explanation of attitude control, including magnetorquers. |
| **18/09/24 - 19/09/24**  **EA Presentation review and practice with Tristan and Aman**   * Practice in front of the team * Slideshow and script edits |
| **20/09/24**  **IMU Testing**   * Soldered headers * Learnt Arduino basics, configured the IMU using LSM9DS1 library * Sensor readings showed near expected values with variable noise. Nice! * Stationary, flat Accelerometer (tested with balance) - showed around 9.8ms^-2 * X and Y value have calibration error of magnitude 0.5. |
| **Week 2: 20 – 27 September 2024** |
| **22/09/24**  **Concept development and research into Magnetorquer driver**  Researched Driver Circuit   * Referencing <https://ieeexplore.ieee.org/document/9468712>   + Circuit Design used a structure based on a buck converter to control output current to magnetorquer.   + Output current is controlled by the duty cycle of PWM signal   + Buck convertor is integrated with a H-bridge to control polarity of current.   Some possible improvements I can make to this design:   * Add current sensors that can be read by the microcontroller. Maybe make a feedback loop to control current. * Add LEDs for testing purposes (e.g. one on each switch so we know which switches are on) |
| **23/09/24**  **Altium Tutorials and Labs**   * Did week 1 labs, familiarised myself with the interface and made a simple PCB. |
| **24/09/24**  **Defined project scope** |
| **26/09/24**  **Read datasheets and selected components**   * Looked at different current sensors. Decided on [INA219](http://INA219) current sensor due to its precision for low current applications like magnetorquers. It is less affected by magnetic interference compared to hall effect, and offers more precise measurements. * Read the datasheet and extracted key information for PCB design.   + Calculated shunt resistor value and calibration register. * Planned the external connections of PCB for schematic * Need pull-up resistors on SDA and SCL lines. * Decoupling capacitor on power supply pin to stabilise power. * Assign slave address with A0 and A1 connections * Can also program to calculate power supplied. * Calculated value of shunt resistor based on max current in magnetorquer and max shunt voltage (in datasheet) to be **0.2ohms.**      * Found a suitable H-bridge for my low current application - [DRV8833C](https://www.ti.com/lit/ds/symlink/drv8833c.pdf?ts=1727258155698&ref_url=https%253A%252F%252Fau.mouser.com%252F)   + Read the data sheet and calculated sense resistor.   + Added indication LEDs so we know which if current is flowing to magnetorquer and which direction. |
| **Week 3: 27 September – 4 October 2024** |
| **29/09/24**  **First attempt at Schematic**   * Followed datasheets and Avionics recommended electronics components. \*Still need to change the headers to be 0.1 inch. * Maybe add more indication LEDs |
| **02/10/24**  **Revised Schematic to make use of dual motor driver & first PCB**   * Watched more Altium Tutorials * Revised the initial schematic so the board can control two magnetorquers * I am going to restart and modify this board so that the headers align with the pin outs of an Arduino Uno (nano is too tight of a fit). * I want to add a magnetometer IC because I will have a lot of free space when I make the board bigger. |
| **Week 4: 4 – 11 October 2024** |
| **06/10/24 - 10/10/24**  **Revised Schematic to accommodate IMU & revised PCB to be an Arduino Uno shield**   * Revised schematic to add headers to accommodate IMU and Arduino – PCB SANDWICH! * Micro will read current sensor, IMU readings (M-field, angular rate) -> feedback -> control PWM to magnetorquers * PCB dimensions and pins aligned to fit Arduino Uno (basically a shield) * Raph says I need to change some stuff – vias to ground/3v3 cannot be shared between components. Pull ups in parallel? Don’t think so. |
| **Week 5: 11 – 18 October 2024** |
| **11/10/24 - 17/10/24**  **Revision 3 of PCB**   * Remade PCB. It will no longer be a shield. Arduino ESP32 will be connected on top via headers.   + ESP32 to allow wireless data transmission -> board allowed to rotate freely with the magnetorquers, and I can get real time data.   + Read ESP32 datasheet to get dimensions and pinouts   + Also IMU dimensions: LSM9DS1 IMU     - distance between pins (WIDTH) = 5 x 2.54 = 12.7 -> 12.8mm to be safe     - Distance of smaller header from top = 15.24     - Distance between centre of pins = 2.54mm   Arduino Nano ESP32 Cheat Sheet | Arduino Documentation   * + Improved routing, added component labels, reduced via size, made traces thicker as per feedback.   **Board review with Aman on Tuesday**   * Revisions: Added Testing points, no routing over silkscreen, thicker traces for higher current loads.   Before (left) and after (right) review: |
| **Week 6: 19 – 25 October 2024**  (Study break) |
| **Week 7: 25 October – 1 November 2024** |
| **26/10/24 Minor Revisions to board**   * Adjusted board size, added mounting holes, text, logo   **29/10/24**  **Researched B-dot control, derived control equation**   * I plan to implement equation 3 into my code. Need to double check it makes sense. Inputs: angular velocity components from gyro, magnetic field components from magnetometer. Outputs: voltage across each magnetorquer * Sources:   + Mehrjardi, Department of Aerospace K.N.Toosi University of Technology, Tehran, Iran   <https://www.m-hikari.com/ces/ces2010/ces5-8-2010/fakhariCES5-8-2010.pdf>   * Aishwarya K and Jogesh Mallaya P and Tharaneeswaran K and Bharath B , Vel Tech High Tech Engineering College, Chennai-Avadi, 60006   <https://www.researchgate.net/publication/369626983_Project_Journal_CubeSat_Detumbing_Simulation>      **30/10/2024 PCB revision once again**   * Made all edits from board review. ESP32-S3 is far larger. Needed to re-route a lot. * **Board Review with Aman and Tristan** * Fixed Design Rule Check errors: board outline can’t be on top layer, must be on mechanical. * Revisions to make: Flip shunt resistor so it directly connects between pins, rename designator of test points, Connect CSB to 3v3 on schematic, change silkscreen on diodes through footprint.     **01/11/2024**  **Calculations for detumbling algorithm constant parameters**    **More board revisions**   * Look into LDOs - low dropout regulators. Go into aerospace repository. Pulsar has LDOs. Make sure rated for enough current. * Mounting holes for all three magnetorquers on the back. Three drivers. * 9V battery connectors. Snap connectors - two holes on the board. Or maybe surface mount. |
| **Week 8: 1 – 8 November 2024** |
| **Revision 4!**   * Added power circuit to step down 9V from battery * Now has 2 H-bridges and can drive 4 magnetorquers (one for redundancy) * Changed the schematic to be hierarchal to accommodate the added complexity |
| **Week 9: 8 – 15 November 2024** |
| **11/11/24 - 13/11/24**  **PCB Revision 5!**   * Board got reviewed from multiple people * Compiled component costs spreadsheet   Additions:   * Re-arranged layout for optimising space * Polygon pours for heat dissipation for buck converter * Redundancy for PWM lines, I2C, 3v3 * Pads for ESP32 pins * Diode on power line * Signals to ADC pins of ESP32 for voltage confirmation * Switch * Annotations and boxes around sub-circuits * BUCK!     **17/11/24**  **Magnetorquer CAD redesign**   * Since air-coil dimensions changed slightly, I needed to re design the mounts and shells so they could fit onto the form factor. * YAY I was able to make it fit (but it was very tight) |
| **Week 10: 15 – 22 November 2024** |
| **15/11/24**  **Detumbling Simulation with Classic B-dot Control Law**   * Got the dynamic model and control law for CubeSat Detumbling * Coded the simulation in python – using discrete time integration, Numpy for matrix algebra, plotted results with matplotlib. * Spent some time confused as to why a component of angular velocity was detumbling then realised that not all the angular velocity components detumbled because a component parallel to the external magnetic field results in UNDERACTUATION (cross product is zero! I’m so silly).       **18/11/24**  **Outlined the Magnetic Dipole Moment Test for magnetorquers**   * Research for testing method * Referencing a paper and considering testing constraints, I outlined the testing method for future reference!       **19/11/24**  **Magnetorquer Air Coil Testing**   * Soldered leads onto air coil – 20ohms resistance. * Original plan for the test did not work since Arduino’s current limit is very small oops. * Instead tested the air coil at different distances away from the IMU, in increments of 8mm. * Two tests: (3.3V, 165mA) & (5V, 0.25A)   + Magnetic flux from air coil is negligible after 18cm away for 5V, 17cm for 3.3V.   + Tests procedure needs revision and further analysis.     **20/11/24**  **Changing PCB Power Plane to 5V, Checks, Gerber, Components Spreadsheet**   * Re-configured buck converter to regulate 9V to 5V * Fixed design rule errors * Learnt how to Gerber and Order PCB * Filled out procurement for components |
| **Week 11: 22 – 29 November 2024** |
| **24/11/2024**  **Attempt at rocket nose for the lolz**    **27/11/2024**  **New Onboarding 3U CubeSat CAD**   * Tried to minimise size while accommodating for PCB and external connections needed. * Referenced PCB and component datasheets to get the right hole sizes     Also studied dynamic modelling and control + vector calc for ADCS. |
| **Week 12: 29 November – 6 December 2024** |
| **02/12/2024**  **Working ESP32 and being stupid**   * MD5 Flash error * Tried resetting flash multiple times * Was actually due to uploading code while being connected to IMU :facepalm: * It works now   **03/12/2024**  **SSTC Presentation**   * Made PowerPoint slides & script (ADCS, HR, helping with intro and Avionics) * Practice presentation Tuesday evening and Wednesday Morning * Presented for ADCS in front of SSTC   **04/12/2024**  **Soldering Magnetorquer Board**   * Missing 120ohm resistor, wrong footprint for 0.1ohm resistor.   Inserting image...Inserting image...  **05/06/2024**  **Magnetorquer base & Battery Case**  Inserting image... |
| **Week 13: 6 - 13 December 2024** |
| **11/12/24**  **Onboarding PCB and Schematic**   * Learnt Schematic, edited and made schematic nicer – explained parts, made it into a block diagram * Checked datasheets of components, fixed some errors * Searched for better LED * Routed PCB     **11/12/24**  **Testing Board**   * Multi meter Tests -> Buck not working * Made buck up plan * Never mind, buck is working   **12/12/24**  **Coil Winding, Soldering, Testing**   * Redesigned mount for rods with feet so they snap off easily. Also added a lip so the wire does not fall loose. * Used BINAR’s coil winder to wind the rods. * Soldered some big resistors to the board for science. * Also soldered all the through hole components   Inserting image...Inserting image... |
| **Week 14: 13 - 20 December 2024** |
| **15/12/24**  **Test Code for H-bridge**   * H-bridge works. Send PWM triangular waveform from 0 – 255 * Multi-meter voltage shows proportional.   Inserting image...  **Re-route power circuit for Magnetorquer Test Board V2**   * Selected new high-current inductor which is a lot bigger * Re-routed to fit everything * Fixed power line to connect to power plane.   **Soldering torquer board so it is somewhat functional**   * BUCK works on the other board. 150ohm through hole resistors and 0.1ohm resistors soldered. Not very effective 🙁 * Also had soldering lab induction and read safety datasheets.   **BUCKBUCKBUCK**   * Selecting 3 different bucks from TI – 5V output, making schematic and PCB, procuring items. * Wrote project proposal for other members, helped them get started on Altium and reading datasheets. |
| **Week 15: 20 - 27 December 2024** |
| 24/12/24  **Magnetorquer with ferrite core + Current Sensor Initial Tests**   * Tried to calibrate myself using datasheet but kept getting values too high or too low (not accurate. Ended up using Adafruit Library. * Graphed data of current and magnetic field readings using Excel * Planned for a graphing program. |
| **BREAK: 27 December 2024 – 10 January 2025** BREAK! |
| **Week 16: 10 - 17 January 2025** |
| **Driver Code & Graphing Program**   * Made Arduino sketch for data collection – csv format (timestamp, duty cycle, m-fields, currents) * Python program – collects and parses data from serial for X seconds * Saves data as csv for analysis * Plots data     **Magnetorquer Testing**    **14/01/2025**  **Adding more plots to graphing program, modified Arduino Code to alternate current in torquers, performed test to determine magnetic dipole moment (using excel).**    **14/01/2025**  **Documentation Writing and making diagrams**   * Made diagram of magnetorquer board * Made ADCS 2025 Plan – to get us a prototype ADCS integration board by the end of the year. * Also made project proposals for ADCS projects – Attitude sensor testing, adcs integration board, detumbling algorithm. |
| **Week 17: 17-24 January 2025** |
| **20/01/2025**  **Soldering Magnetorquer Test Board rev2 & Onboarding PCB**   * Magnetorquer board passed multi meter testing first try * Some onboarding components were not ordered, so need to solder again.   **21/01/2025**  **Winding new air coil & connecting torquers to board**   * New air coil 2x as much wire, 40 ohms resistance * Shrink wrap on wire to minimize risk of breaking     **22/01/2025**  **Debugging Magnetorquer test board and obtaining graphs**   * Adjusted code and finally got all torquers working * I figured out the configure the addresses of the current sensors.     **Case design, Manufacturing Onboarding project & making it work with a 3V cell**   * New case to fit the PCB and the fat switch. Tried to make it as small as possible, while also considering accessibility for debugging and connecting buttons etc.       **24/01/2025**  **Magnetorquer Documentation**   * Made block diagram, annotated images, lessons learnt etc. |
| **Week 18: 24-31 January 2025** |
| **HERB Research (2 hrs)**   * Lit review of 5+ papers, recorded in a document. * Concept design * Also did EPS research     **Onboarding Project (1 hr)**   * Soldered new board (which someone blew up AGHHHH) * New case design to be more ergonomic and look cooler, printed and cut acrylic     **Sun Sensors**   * Learnt about transpedance amplifier configuration, making a schematic as an example to show Felix * Reviewed and gave feedback for schematic & PCB * Calculated component values and put components into OSIRIS costing sheet. * Also looked into sun vector determination methods, found a good textbook and learnt about a least squares regression method. |
| **Week 19: 31 January - 7 February 2025** |
| **Onboarding Project (3 hrs)**   * Soldered buttons, led, switch on with wires (a pain to do) + continuity testing after (1 hr) * Battery protection wasn’t working (no output voltage so we bypassed it). * I reviewed the datasheets all components on the Onboarding Schematic and realized some critical issues with the board   + LDO current capacity not matching LED requirements, LED driver current cap, Battery bank requires at least 5V to charge a device -> boost converter needed. LDO wont work when battery source is under 3.3V. * Version 2 Schematic – making it cheaper, clearer, simpler (2 hrs) - not used rip     **Onboarding Project**   * More testing and soldering and failing and being sad. Soldered 4 boards in total. * Did more continuity testing, there is a short from power to ground?? Micro heated up real bad. * Decided to modify Onboarding to be a series of smaller Onboarding Projects on GitHub – Tutorials for PCB design, compiling resources, outlining projects for ADCS, Avionics       **I also made this diagram for HAB systems.** |
| **Week 20: 7 February - 14 February 2025** |
| **Resoldered Magnetorquer Board**   * Taught Daniel how to use the board and software * Fixed up some wire that broke loose   **EPS Research & system design**   * Looked at 10+ sources, took notes (some in a word doc, some in my OneNote) * Learnt about different EPS architectures (DET, MPPT, Distributed and centralized, number of conversions etc.) * Looked at JAXA specifications for deployment switches and RBF pin. * Found good sources of documentation and took notes. Links in my OneNote. * Outlined some design requirements and designed high level system. |
| **Week 21: 14 February - 21 February 2025** |
| **EPS Schematic (1hr)**   * Reviewing SOLIS (Power generation/harvesting) and learning how it works * Understanding how MPPT buck-boost works by reading datasheet   **Magnetorquer HAB software (0.5hrs)**   * Thought of way to alternate between three magnetorquers by keeping count of the times current direction has been switched.   **Soldering new Magnetorquer board (in case HAB is not retrieved) (2 hrs)**   * Needed to desolder some components on the old non-functional board because I couldn’t find them. * Also helped with buck test board soldering     **Getting Onboarding torch to turn on (0.5hrs)**   * Made this prototype for display at O-day * Can turn on with a 3V cell lol. |
| **Week 22: 21 February - 28 February 2025** |
| **EPS Planning (2 hours)**  * EPS meeting with Jack, Raph, Damon – distributed roles, discussed interconnections, connector types, how to deal with antenna and solar panel deployment. * Electronic Power Interface & Control Diagram * Reading Fergus Downey’s Thesis (EPS part).     **ADCS Passive vs Active Attitude Control Research (1 hr)**   * Read 5+ papers. Notes in my OneNote. * I decided that Passive control is best for a simple mission and quicker development but not as fun and gives me less of a challenge to work on. I’m going to work towards active magnetorquer-only control with detumbling and nadir pointing. * CubeSat probably won’t launch in 2027 tho RIP. |
| **Week 23: 28 February - 7 March 2025** |
| **Read BINAR paper - ADCS part. (1hr)**   I forgot what i did this week agh probably not much. |
| **Week 24: 7 March - 14 March 2025** |
| **PAST Info Nights (4 hrs)**  * Worked on PPT slides and script for the team. * Organised venue, invitations, event structure. * Presented for ADCS, mech. Did it two times TT    **EPIC (Electronic Power Interface Control)**  * Checked Damon’s component selection. Some resistors were a bit iffy. * Selected Power Mux. * Made the schematic for bucks and power mux. |
| **Week 25: 14 March - 21 March 2025** |
| **Helping Felix Solder and debug OSIRIS**  * Supervised and aided soldering. Did an extra board. Found error with jumper link placement. Op amps did not work because pins were assigned wrong bruhrhurssf.   Inserting image...Inserting image...  **Helped Anastasiia with Buck Testing (1.5hrs)**   * BUCKBUCKBUCK – two work great, one was weird. * Used high power resistors, power supply, DMM to test buck’s performance under different loads. Anastasiia got the results in a table. We got kicked out of the micro lab after it ended tho.🙁 * Raph made us test his BMS test board – the 5V one was good, but the 3v3 performed poorly under loads. * Helped Anastasiia work the equipment and test things safely. * Forgot to take photos rip |